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ARMY REGULATION
No. 40–46

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, *6 February 1974*

MEDICAL SERVICE

CONTROL OF HEALTH HAZARDS FROM LASERS AND OTHER HIGH INTENSITY OPTICAL SOURCES

Effective 15 March 1974

* ***This regulation establishes policies, procedures, and standards for the protection of personnel from hazards to health from optical radiation. It applies to all Army activities. Local limited supplementation of this regulation is permitted, but is not required. If supplements are issued, Army staff agencies and major Army commands will furnish one copy of each to The Surgeon General, HQDA (DASG—PSP—E). Other commands will furnish one copy of each to the next higher headquarters.***

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CHAPTER 1
GENERAL

1-1. Purpose. This regulation establishes Department of the Army policies, procedures, and standards for the protection of personnel from the hazards to health of optical radiation. It outlines procedures to be followed in the event of a known or suspected overexposure of personnel to such radiation.

1-2. Scope. This regulation is applicable to all commands of the Department of the Army.

1-3. Definitions. *a. Optical radiation.* Electromagnetic radiation within the wavelength range 100 nanometers to 1 millimeter (10^6 nanometers) (i.e., ultraviolet, visible, and infrared radiation).

b. Laser. An acronym for Light Amplification by Stimulated Emission to Radiation. As used in this regulation, laser denotes either the laser radiation source itself, or an entire system embodying such a source, as appropriate.

c. Optical source. Any source of optical radiation, e.g. searchlights, lasers, and electric arcs.

d. Laser protection standards. Published standards for laser exposure which will ensure that personnel will not sustain injury in the light of existing medical knowledge.

e. Ocular hazard distance. The distance of the human eye from the operating laser or other optical source within which the beam radiant exposure or irradiance exceeds the applicable optical radiation protection standard.

f. Units. Radiometric units used shall be in accordance with the International System of Units adopted by the 11th General Conference on Weights and Measures, October 1969 and the International Lighting Vocabulary Publication CIE No. 17 (E-1.1) 1970, published by the International Commission on Illumination.

1-4. Policy. *a.* Exposure to laser radiation shall be controlled to ensure that individuals are not subjected to levels in excess of those established by the Protection Standards prescribed in chapter 2.

b. Laser hazard assessments will be accomplished in accordance with provisions of TB MED 279.

c. Medical surveillance programs will be established to ensure that appropriate physical examinations are accomplished on those individuals employed to work in a potentially hazardous laser radiation area.

d. Lasers and other optical sources will be operated in such a way as to avoid potentially hazardous exposure of personnel who may be in the vicinity of the optical beam and within the ocular hazard distance as determined by the US Army Environmental Hygiene Agency (USAEHA).

1-5. Responsibility. Responsibility for control of potential hazards to personnel from lasers and other optical equipment.

a. The Surgeon General, Department of the Army, is responsible for the evaluation of potential optical radiation hazards to personnel operating lasers, searchlights, and similar equipment which generate optical radiation, that are utilized by the Department of the Army.

(1) The Surgeon General, pursuant to AR 10-5, will evaluate for development and design agencies the potential health hazards of equipment utilizing lasers and other optical source systems and provide guidance on measures which may be taken to avoid or prevent excessive exposure of personnel to optical radiation. These evaluations will be conducted by USAEHA.

(2) The Surgeon General will evaluate plans upon request for the installation of laser equipment and make studies of the environmental conditions at user sites or test facilities.

(3) USAEHA will conduct periodic comprehensive surveys of laser installations at least every 3 years. These surveys will include evaluation of characteristics of laser equipment and activities at the site which may result in exposure of personnel, determination of the effectiveness of interlocks, eye protection, warning and/or limiting devices and review of standing operating procedures and other controls related to personnel protection.

b. Agencies responsible for the development, design, and procurement of laser equipment or its incorporation into weapons control or communications systems will ensure that:

(1) Such equipment is evaluated for personnel exposure potential during design, development, and testing of the equipment. The Commander, US Army Health Services Command, ATTN: HSPA-H, Fort Sam Houston, TX 78234, will be notified in sufficient time to provide services noted in paragraph *a* above. Pertinent information derived from this evaluation will be made available on request to any major Army commanders who have installations or activities within their command which operate such equipment.

(2) Such equipment complies with all provisions of the Federal Performance Standard for Laser Products (Title 21, Code of Federal Regulations (CFR), Part 1040.10 and 1040.11); or, that if complete copmpliance is not practicable for tactical or outdoor training devices, that such equipment comply with those provisions that are practicable. Alternate and equally effective controls should be developed. When total compliance cannot be achieved, such products must be labeled as exempt from the Federal regulation.

(3) That manufacturers receive certification of exemption if the system must be exempt. Contracting officers are authorized and directed to provide manufacturers, upon request, with written confirmation of exemption from military laser products that meet the above criteria. Such confirmation will be made after review and consultation, if required, with officials of the procuring agency, and after discussion of the above limits of exemption, with the manufacturer. The exemption statement should read as follows: In accordance with an interagency agreement between DOD and the Department of Health, Education and Welfare (DHEW), 29 July 1976, the following electronic product(s) are exempt from Food and Drug Administration (FDA) radiation safety performance standards prescribed in CFR, Title 21, chapter 1, subchapter J, pursuant to Exemption No. 76EL-01DOD issued on July 26, 1976:

Laser Type: _____
Manufacturer: _____
Contract No.: _____
Number of Lasers: _____
National Stock Number (if available): _____
Reason for Exemption: _____
All laser products exempt under Exemption No. 76El-01DOD will be labeled by the manufacturers as follows: CAUTION—"This electronic product has been exempt from the FDA radiation safety performance standards prescribed in CFR, Title 21, chapter 1, subchapter J, pursuant to Exemption No. 76EL-01DOD issued on 26 July 1976. This product should not be used without adequate protective devices or procedures."

(4) That copies are provided of all such written confirmation of exemption [para (3) above] to the Office of the Assistant Secretary of Defense (MRA&L) EES, WASH DC 20310.

(5) That copies of laser disposal records are provided to the Office of Assistant Secretary of Defense, (MRA&L) EES, WASH DC 20310 when accountability has been transferred to a Defense Property Disposal Office.

c. Major Army commanders who have installations and activities under their command which operate laser and high intensity light source equipment are responsible for—

(1) Disseminating to installations and activities operating such equipment under their command information relating to the measures required for the control of exposure of personnel.

(2) Assuring that installations and activities operating such equipment under their command have in force adequate programs as specified in *d* below for the control of exposure of personnel.

(3) Prescribing conditions under which interlocks, eye protection filters, and limiting and/or warning devices installed on equipment may be by-passed or overridden during combat alerts, training exercises, or in maintenance or calibration of equipment.

d. Installation and activity commanders responsible for the operation or testing of potentially hazardous optical equipment will take necessary measures to assure that—

(1) Personnel working in the vicinity of laser equipment and high intensity optical sources are informed as to the potential personnel health hazards associated with exposure to optical radiation from the specific equipment being used.

(2) Standing operating procedures are published and enforced, as required, concerning such matters as the control of the positioning of optical devices, control of the movement of personnel, and the minimization of exposure of

personnel in the vicinity of the hazardous optical beam(s).

(3) Protective devices are labeled and used only under the conditions for which they are designed.

(4) Appropriate areas of possible hazardous exposure are placarded to indicate the nature of the hazard. The placard will be in accordance with AR 385-30.

(5) Any suspected laser radiation accidents involving individual exposure in excess of protection standards are reported in accordance with AR 385-40. The report should include—

(a) A description of the laser installation and circumstances leading to the exposure.

(b) Details of the immediate and subsequent ophthalmologic findings.

(6) All personnel who are employed to work in a potentially hazardous laser area (para 1-6*a*) are included in an occupational vision program which encompasses thorough general ophthalmologic examinations before being assigned to work with laser-producing equipment; on termination of such employment; and screening examinations periodically at 1 to 2-year intervals during assignment.

1-6. Medical surveillance. *a. Personnel to be examined.* An individual whose occupation or assignment may result in a significant risk of exposure to potentially hazardous levels of optical radiation shall have a preplacement medical examination, a termination of employment examination, and be included in an occupational vision program. The following types of individuals are considered in this category:

(1) Those individuals routinely using lasers in any RDTE effort.

(2) Certain laser equipment, such as tripod-mounted, hand-held or airbonre laser rangefinders, designators, or illuminators may be determined to present a sufficient hazard to operators and maintenance personnel that such personnel may be required by The Surgeon General to be examined. The warning page of the technical manual for each laser device will indicate which types of user or maintenance personnel should be examined.

(3) Maintenance personnel routinely working with laser rangefinders, illuminators, or designators.

(4) Operators and maintenance personnel routinely working with engineering laser transits, geodimeters, and alignment devices which have a radiant power output exceeding 1 milliwatt.

b. *Examination requirements.* The medical examination shall follow the procedures in TB MED 279.

c. Examination of personnel known or suspected to have been injured by lasers. Personnel who are known or suspected to have been accidentally exposed to levels in excess of applicable laser protection standards shall be examined as soon as possible following such exposure. Personnel working lasers or other high intensity optical sources who complain of persistent afterimages or other visual disturbances should be examined.

1-7. Requests for assistance. Requests for technical assistance from USAEHA in evaluating hazards from lasers and other high intensity optical sources should be directed through appropriate command channels per AR 40-4 to HQDA (DASG-PSP—E), WASH DC 20310.

CHAPTER 2

PROTECTION STANDARDS

2-1. General. Laser radiation protection standards are provided in paragraph 2-2 of this chapter. A detailed explanation of the application of these standards is found in TB MED 279. Ultraviolet protection standards are provided in paragraph 2-3. The procedure for determination of hazards from nonlaser optical radiation sources is provided in paragraph 2-4.

2-2. Laser protection standards. *a. General.* These protection standards are for exposure to laser radiation under conditions to which nearly all personnel may be exposed without adverse effects. The values should be used as guides in the control of exposures and should not be regarded as fine lines between safe and dangerous levels. They are based on the best available information from experimental studies. Table 2-1 provides a summary of the most often used laser protection standards. Tables 2-2 through 2-4 provide the complete list of laser protection standards. Figures 2-3 through 2-11 provide graphs of protection standards which may be difficult to calculate.

b. Limiting apertures. These protection standards expressed as radiant exposure or irradiance in this section may be averaged over an aperture of 1 mm except for protection standards for the eye in the spectral range of 400–1400 nm, which should be averaged over a mm limiting aperture (pupil). No modification of the protection standards is permitted for pupil sizes less than 7 mm.

c. Extended sources. These protection standards for "extended sources" apply to sources which subtend an angle greater than figure 2-7 which varies with exposure time. This angle is not the beam divergence of the source.

d. Correction factor A (C_A). All protection standards in Tables 2-2 and 2-3 are to be used as given for wavelengths 400 nm to 700 nm. Protection standards at wavelengths between 700 nm and 1.06 μm are to be increased by a uniformly extrapolated factor C_A as shown in Figure 2-8.

e. Repetitively pulsed lasers. Since there are little experimental data for multiple pulses, caution must be used in the evaluation of such exposures. The protection standards for irradiance or radiant exposure in multiple pulse trains have the following limitations:

(1) The exposure from any single pulse in the train is limited to the protection standard for a single comparable pulse.

(2) The average irradiance for a group of pulses is limited to the protection standard as given in Tables 2-2, 2-3, or 2-4 of a single pulse of the same duration as the entire pulse group.

(3) When the instantaneous Pulse Repetition Frequency (PRF) of any pulses within a train exceeds one, the protection standard applicable to each pulse is reduced as shown in figure 2-9 for pulse durations less than 10^{-6} second. For pulses of greater duration, the formula shown in figure 2-1 should be followed.

2-3. Ultraviolet radiation protection standards. *a. General.* These protection standards are applicable for ultraviolet radiation in the spectral region between 200 and 400 nm and represent conditions under which it is believed that nearly all workers may be repeatedly exposed without adverse effect. These values for exposure of the eye or the skin apply to ultraviolet radiation from arcs, gas, and vapor discharges, and incandescent sources, but do not apply to ultraviolet lasers (see paragraph 2-2) or solar radiation. These levels should not be used for determining exposure of photosensitive individuals to ultraviolet radiation. These values should be used as guides in the control of exposure to continuous sources where the exposure duration shall not be less than 0.1 sec. These values should be used as guides in the control of exposure to ultraviolet sources and should not be regarded as a fine line between safe and dangerous levels.

b. Protection Standards. The protection standards for occupational exposure to ultraviolet radiation incident upon skin or eye where irradiance values are known and exposure time is controlled are as follows:

(1) For the near ultraviolet spectral region (UV-A, 315 to 400 nm) total irradiance incident upon the unprotected skin or eye should not exceed 1 $mW \cdot cm^{-2}$ for periods greater than 10^3 seconds (approximately 16 minutes) and for expo-

sure times less than 10^3 seconds should not exceed 1 $J \cdot cm^{-2}$.

(2) For the actinic ultraviolet spectral region (UV–B and UV–C, 200 to 315 nm), the radiant exposure incident upon the unprotected skin or eye should not exceed the values given in Table 2–5 within an 8-hour period.

(3) To determine the effective irradiance of a broadband source weighted against the peak of the spectral effectiveness curve (270 nm), the weighting formula shown in figure 2–2 should be used.

(4) Permissible exposure time in seconds for exposure to actinic ultraviolent radiation incident upon the unprotected skin or eye may be computed by dividing 0.003 $J \cdot cm^{-2}$ by E_{eff} in $W \cdot cm^{-2}$. The exposure duration may also be determined using Table 2–6 which provides exposure times corresponding to effective irradiances in $\mu W \cdot cm^{-2}$.

2–4. Other (nonlaser) optical source protection standards. Optical radiation protection standards for protection of personnel against visible and infrared searchlights, electric-arc lamps, nonlaser infrared illuminators, optical missile guidance sources, and similar equipment are not available except in the ultraviolent spectrum. USAEHA evaluates such sources based upon tentative standards which cannot be reduced to simplified tabulation. Laser protection standards may be applied to nonlaser sources, but will result in more conservative ocular hazard distances.

TABLE 2-1.

PROTECTION STANDARDS FOR TYPICAL LASERS

Type of Laser	PRF	Wavelength	Exposure Duration	Protection Standard For Intrabeam Viewing by the Eye
Single-Pulse Ruby Laser Rangefinder or Designator	Single Pulse	694.3 nm	1 ns - 18 μs	5×10^{-7} J.cm^{-2}/pulse
Repetitively Pulsed Ruby Laser Rangefinders and Designators	10 Hz	694.3 nm	1 ns - 18 μs	1.6×10^{-7} J.cm^{-2}/pulse
	20 Hz			1.1×10^{-7} J.cm^{-2}/pulse
Single-Pulse Neodymium Rangefinder or Designator	Single Pulse	1060 nm	1 ns - 100 μs	5×10^{-6} J.cm^{-2}/pulse
Repetitively Pulsed Neodymium Rangefinders and Designators	10 Hz	1060 nm	1 ns - 100 μs	1.6×10^{-6} J.cm^{-2}/pulse
	20 Hz	1060 nm	1 ns - 100 μs	1.1×10^{-6} J.cm^{-2}/pulse
CW Argon Lasers	CW	488 nm & 514.5 nm	0.25 s	2.5 mW.cm^{-2}
CW Argon Lasers	CW	488 nm & 514.5 nm	4 to 8 hours	1 μW.cm^{-2}
CW Helium-Neon Lasers (for Alignment, etc.)	CW	632.8 nm	0.25 s 4 to 8 hours	2.5 mW.cm^{-2} 1 μW.cm^{-2}
Erbium Laser Rangefinder or Designator	Single Pulse	1540 nm	1 ns - 1 μs	1 J.cm^{-2}/pulse
CW Neodymium YAG Laser	CW	1064 nm	100 s - 8 hours	0.5 mW.cm^{-2}
CW Carbon-Dioxide Laser	CW	10.6 μm	10 s - 8 hrs	0.1 W.cm^{-2}

TABLE 2-2.

PROTECTION STANDARDS FOR OCULAR EXPOSURE
INTRABEAM VIEWING OF A LASER BEAM SINGLE EXPOSURE

Spectral Region	Wavelength (nm)	Exposure Time (t)	Protection Standard	Defining Aperture (mm)
UV-C	200 to 280	1 ns to 3 x 10^4 s	3 mJ.cm^{-2}	1
UV-B	280 to 302	1 ns to 3 x 10^4 s	3 mJ.cm^{-2}	1
	303	1 ns to 3 x 10^4 s	4 mJ.cm^{-2}	1
	304	1 ns to 3 x 10^4 s	6 mJ.cm^{-2}	1
	305	1 ns to 3 x 10^4 s	10 mJ.cm^{-2}	1
	306	1 ns to 3 x 10^4 s	16 mJ.cm^{-2}	1
	307	1 ns to 3 x 10^4 s	25 mJ.cm^{-2}	1
	308	1 ns to 3 x 10^4 s	40 mJ.cm^{-2}	1
	309	1 ns to 3 x 10^4 s	63 mJ.cm^{-2}	1
	310	1 ns to 3 x 10^4 s	100 mJ.cm^{-2}	1
	311	1 ns to 3 x 10^4 s	160 mJ.cm^{-2}	1
	312	1 ns to 3 x 10^4 s	250 mJ.cm^{-2}	1
	313	1 ns to 3 x 10^4 s	400 mJ.cm^{-2}	1
	314	1 ns to 3 x 10^4 s	630 mJ.cm^{-2}	1
	315	1 ns to 3 x 10^4 s	1.0 J.cm^{-2}	1
UV-A	315 to 400	1 ns to 10 s	* 0.56 $\sqrt[4]{t}$ J.cm^{-2}	1
	315 to 400	10 s to 10^3 s	1.0 J.cm^{-2}	1
	315 to 400	10^3 to 3 x 10^4 s	1.0 mW.cm^{-2}	1
LIGHT	400 to 700	1 ns to 18 μs	0.5 μJ.cm^{-2}	7
	400 to 700	18 μs to 10 s	* [1.8 $t/\sqrt[4]{t}$ mJ.cm^{-2}	7
	400 to 700	10 s to 10^4 s	10 mJ.cm^{-2}	7
	400 to 700	10^4 to 3 x 10^4 s	1 μW.cm^{-2}	7
IR-A	700 to 1060	1 ns to 18 μs	0.5C_A μJ.cm^{-2}	7
	700 to 1060	18 μs to 10 s	* [1.8 $t/\sqrt[4]{t}$] C_A mJ.cm^{-2}	7
	700 to 1060	10 s to 100 s	10.C_A mJ.cm^{-2}	7
	1060 to 1400	1 ns to 100 μs	5 μJ.cm^{-2}	7
	1060 to 1400	100 μs to 10 s	[9.$t/\sqrt[4]{t}$] mJ.cm^{-2}	7
	1060 to 1400	10 s to 100 s	50 mJ.cm^{-2}	7
	700 to 800	100 s to [$10^4/C_B$] s	10.C_A mJ.cm^{-2}	7
	700 to 800	[$10^4/C_B$] s to 3 x 10^4 s	C_A.C_B μW.cm^{-2}	7
	800 to 1060	100 s to 3 x 10^4 s	0.1.C_A mW.cm^{-2}	7
	1060 to 1400	100 s to 3 x 10^4 s	0.5 mW.cm^{-2}	7
IR-B&C	1400 to 10^6	1 ns to 100 ns	10 mJ.cm^{-2}	1, 10**
	1400 to 10^6	100 ns to 10 s	* 0.56 $\sqrt[4]{t}$ J.cm^{-2}	1, 10
	1400 to 10^6	10 s to 3 x 10^4 s	0.1 W.cm^{-2}	1, 10

* These values are graphed in figures 2-3 through 2-8.
** 1 mm for 1400-10^5 nm; 10 mm for 10^5-10^6 nm
$C_A = e^{(\lambda-700/224)}$
$C_B = (\lambda-699)$

TABLE 2-3.

PROTECTION STANDARDS FOR LASER RADIATION EXPOSURE OF THE EYE VIEWING EXTENDED SOURCES AND DIFFUSE REFLECTIONS (400-1400 nm)

Wavelength (nm)	Exposure Duration	Irradiance or Radiant Exposure on Diffuse Perfect Surface	Radiance or Integrated Radiance from Extended Source
200-400	1 ns to 3 x 10^4 s	(Use Values in Table 2-2)	
400-700	1 nsec to 10 s	* $10\pi\sqrt[3]{t}$ J.cm^{-2}	$10\sqrt[3]{t}$ J.cm^{-2}.sr^{-1}
	10-10^4 s	20π J.cm^{-2}	20 J.cm^{-2}.sr^{-1}
	10^4 s to 3 x 10^4	2π x 10^{-3} W.cm^{-2}	2 x 10^{-3} W.cm^{-2}.sr^{-1}
700-1060	1 ns to 10 s	* $10\pi C_A\sqrt[3]{t}$ J.cm^{-2}	$10C_A\sqrt[3]{t}$ J.cm^{-2}.sr^{-1}
700-1060	10-100 s	$20\pi C_A$ J.cm^{-2}	$20C_A$ J.cm^{-2}.sr^{-1}
700-800	100 s to ($10^4/C_B$) s	$20\pi C_A$ J.cm^{-2}	$20C_A$ J.cm^{-2}.sr^{-1}
700-800	($10^4/C_B$) s	$0.2\pi C_A C_B$ W.cm^{-2}	$0.2C_AC_B$ W.cm^{-2}.sr^{-1}
800-1060	100 s to 3 x 10^4 s	$0.2C_A\pi$ W.cm^{-2}	0.2 C_A W.cm^{-2}.sr^{-1}
1060-1400	1 ns to 10 s	* $50\pi\sqrt[3]{t}$ J.cm^{-2}	$50\sqrt[3]{t}$ J.cm^{-2}.sr^{-1}
1060-1400	10-100 s	100π J.cm^{-2}	100 J.cm^{-2}.sr^{-1}
1060-1400	100 s to 3 x 10^4	π W.cm^{-2}	1.0 W.cm^{-2}.sr^{-1}
1400-10	10 ns to 3 x 10^4	(Use Values in Table 2-2)	

t is the exposure duration in seconds, λ is wavelength in nanometers, and
$C_A = e^{-[(\lambda-700nm)/22]}$

C_B = (λ-699 nm) and is unitless

*These values are graphed in figures 2-3 through 2-8.

TABLE 2-4.

PROTECTION STANDARDS FOR SKIN EXPOSURE TO A LASER BEAM

Spectral Region	Wavelength	Exposure Time, (t) Seconds	Protection Standard
UV	200 nm to 400 nm	10^{-3} to 3 x 10^{4}	Same as Table 2-2
Light & IR A	400 nm to 1400 nm	10^{-9} to 10^{-7}	2 X 10^{-2} J.cm^{-2}
Light & IR A	400 nm to 1400 nm	10^{-7} to 10	*1.1 $\sqrt[4]{t}$ J.cm^{-2}
Light & IR A	400 nm to 1400 nm	10 to 3 X 10^{4}	0.2 W.cm^{-2}
IR B & C	1.4 μm to 1 mm	10^{-9} to 3 X 10^{4}	Same as Table 2-2

* These values are graphed in figures 2-3 through 2-8.

TABLE 2-5.

ULTRAVIOLET RADIATION PROTECTION STANDARDS

Wavelength (nm)	Protection Standard (mJ/cm^2)	Relative Spectral Effectiveness Sλ
200	100	0.03
210	40	0.075
220	25	0.12
230	16	0.19
240	10	0.30
250	7.0	0.43
254	6.0	0.5
260	4.6	0.65
270	3.0	1.0
280	3.4	0.88
290	4.7	0.64
300	10	0.30
305	50	0.06
310	200	0.015
315	1000	0.003

TABLE 2-6.

PERMISSIBLE EXPOSURE TIME FOR ULTRAVIOLET RADIATION

Duration of Exposure Per Day	Effective Irradiance, Eeff ($\mu W/cm^2$)
8 hrs	0.1
4 hrs	0.2
2 hrs	0.4
1 hr.	0.8
1/2 hr.	1.7
15 min.	3.3
10 min.	5
5 min	10
1 min	50
30 sec.	100
10 sec.	300
1 sec	3,000
0.5 sec	6,000
0.1 sec	30,000

$$\text{Standard} \left(\begin{matrix}\text{single pulse} \\ \text{in train}\end{matrix}\right) = \frac{\text{Standard (pulse } n\tau)}{n},$$

where:

n = number of pulses in train

τ = duration of a single pulse in the train

Standard ($n\tau$) = protection standard of one pulse having a duration equal to $n\tau$ seconds

Figure 2-1.

$$E_{eff} = \sum E_\lambda \cdot S_\lambda \cdot \Delta\lambda$$

where:

E_{eff} = effective irradiance relative to a monochromatic source at 270 nm

E_λ = spectral irradiance in $W \cdot cm^{-2} \cdot nm^{-1}$

S_λ = relative spectral effectiveness (unitless)

$\Delta\lambda$ = band width in nanometers

Figure 2-2.

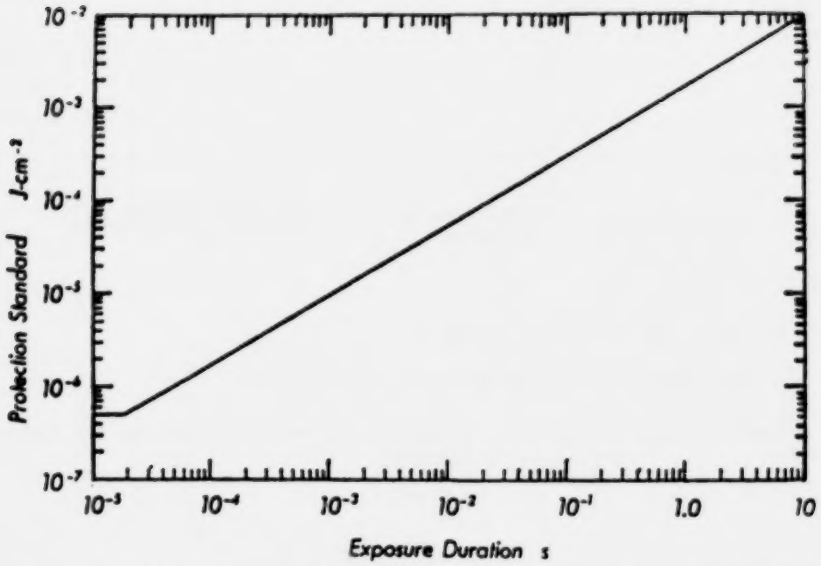

Figure 2-3. Protection standard for intrabeam viewing of pulsed visible (400–700nm) laser radiation. Protection standards for intrabeam viewing of pulsed IR-A (700–1400nm) laser radiation are obtained by multiplying value in graph by C_A.

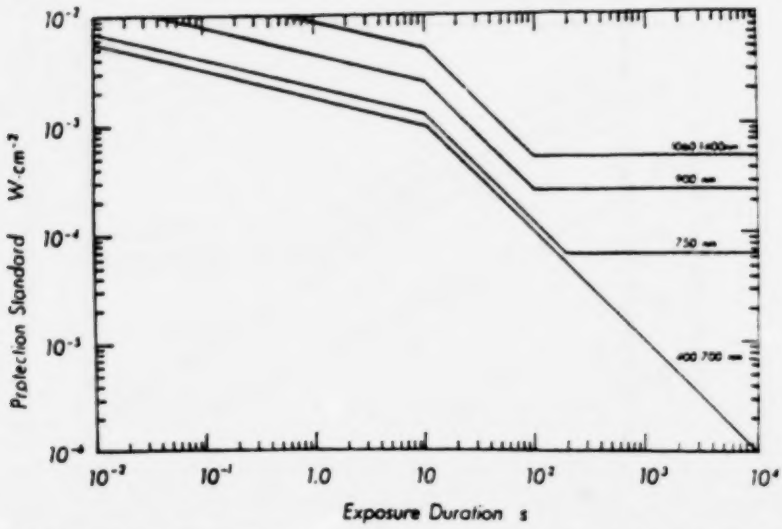

Figure 2–4. Protection standard for intrabeam viewing of CW visible (400–700nm) and IR–A (750, 900 and 1060–1400nm) laser radiation.

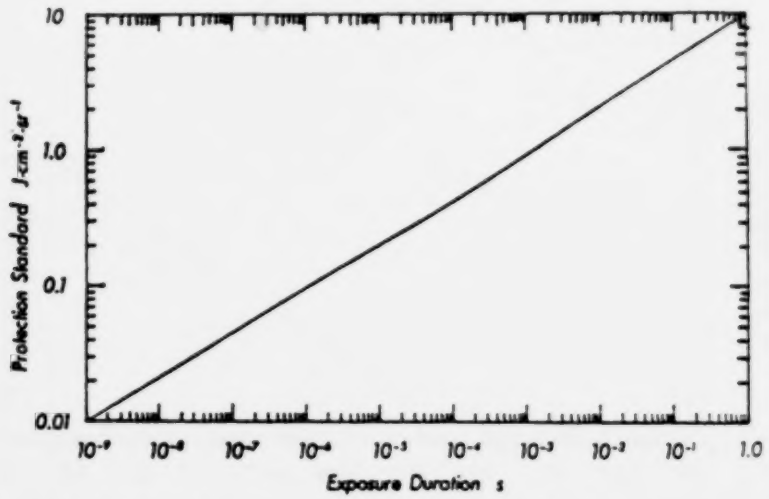

Figure 2–5. Protection standard for extended sources or diffuse reflections of pulsed laser radiation (400–700nm). To obtain protection standard for wavelengths 700–1400nm, multiply by C_A.

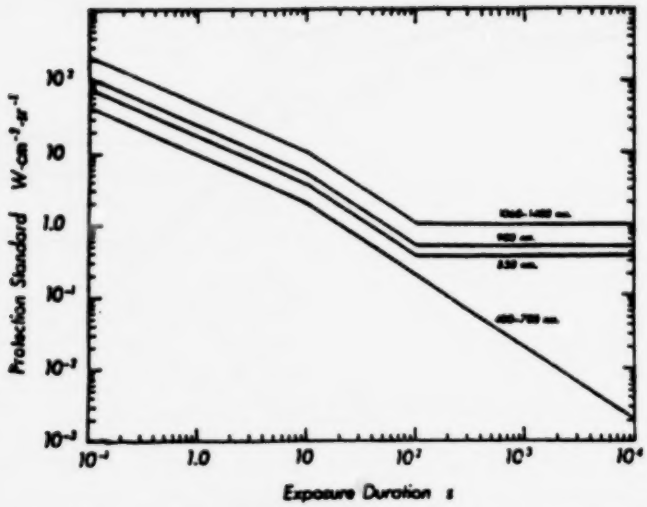

Figure 2-6. Protection standard for extended sources or diffuse reflections of CW laser radiation.

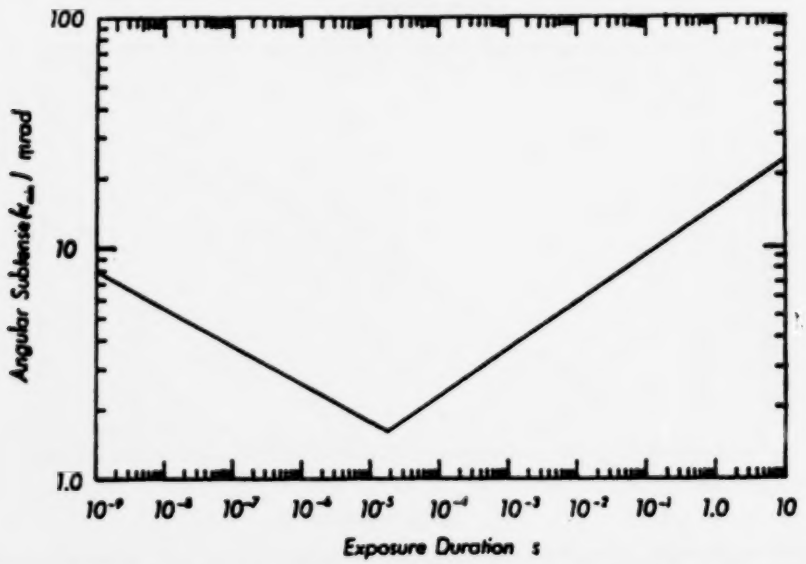

Figure 2-7. Limiting angular subtense of an extended source (α min). Sources whose angular subtense are less than α min are considered collimated; those greater or equal to α min are considered extended sources.

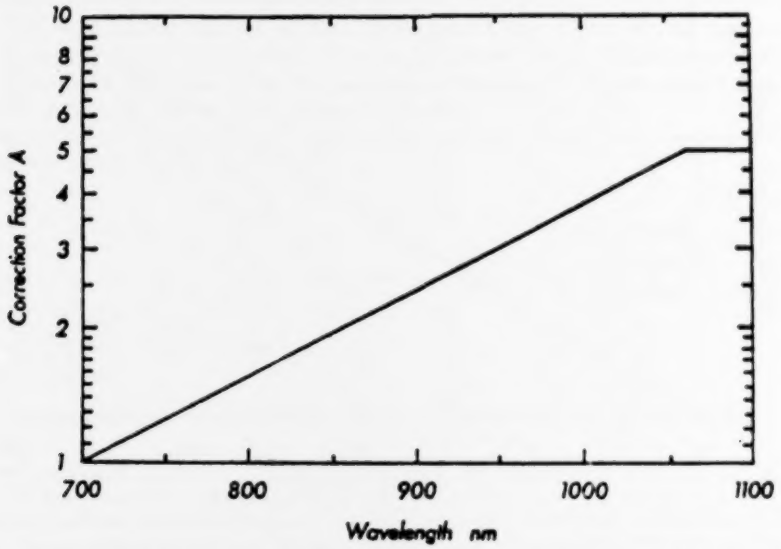

Figure 2-8. Protection standard correction factor (CA) for laser wavelengths between 700 and 1100nm. CA = 5 for wavelengths between 1100 and 1400nm.

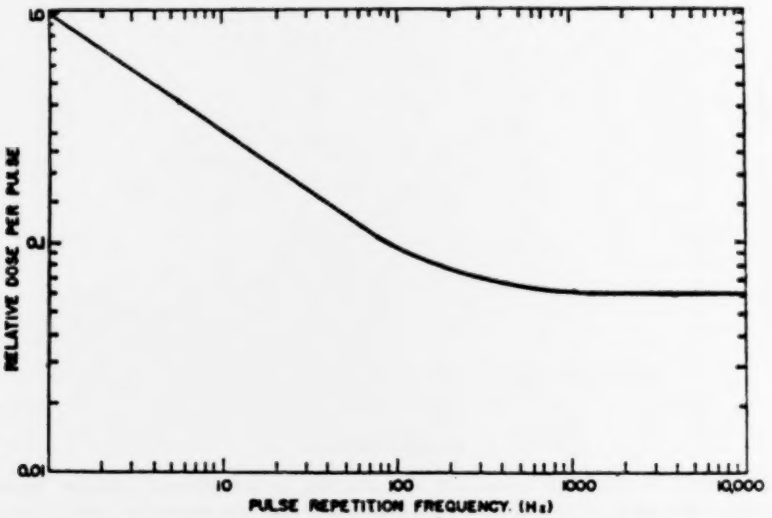

Figure 2-9. Correction factor Cp for repetitively pulsed lasers having pulse durations less than 10^{-3} second. The protection standard for a single pulse of a pulse train is multiplied by the above correction factor. Cp for PRF greater than 1000 Hz is 0.06.

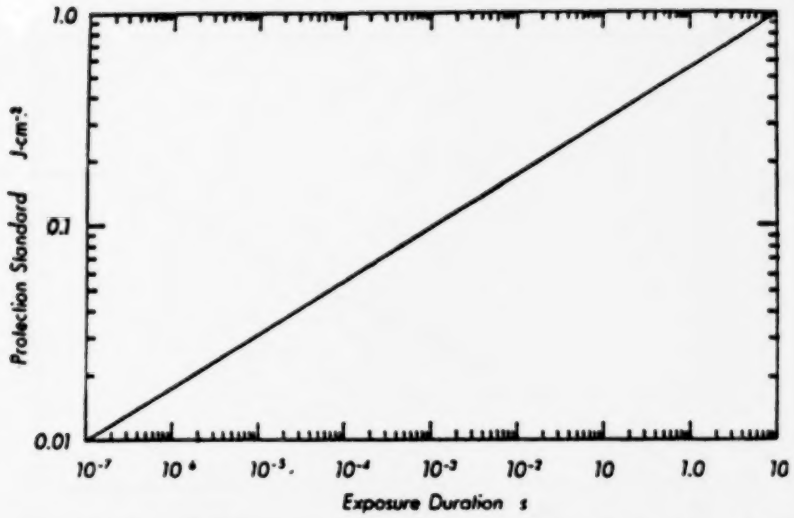

Figure 2–10. Protection standard for pulsed laser exposure of skin and eyes for far-infrared radiation (wavelengths greater than 1400nm). Protection standards for skin exposure (400–1400nm) are twice these values.

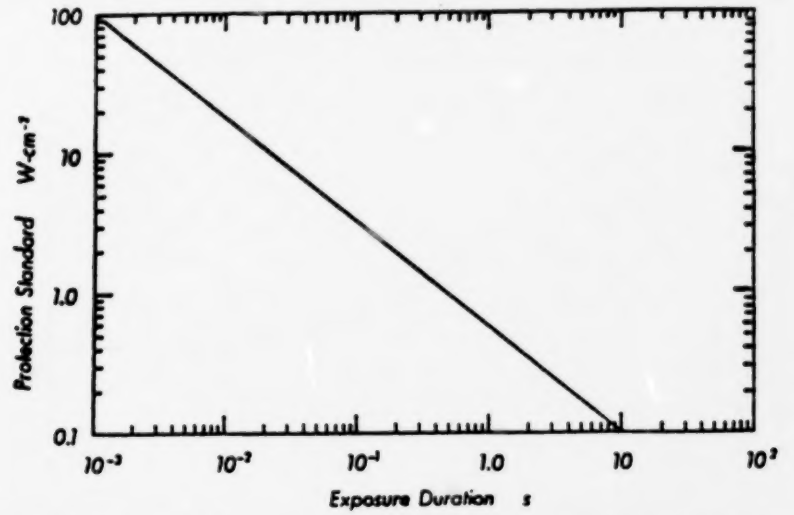

Figure 2–11. Protection standard for CW laser exposure of skin and eyes for far-infrared radiation (wavelengths greater than 1400nm). Protection standards for skin exposure (400–1400nm) are twice the values given in the graph.

The proponent agency of this regulation is the Office of The Surgeon General. Users are invited to send comments and suggested improvements on DA Form 2028 (Recommended Changes to Publications) direct to HQDA (DASG–HCH–E) WASH DC 20314.

By Order of the Secretary of the Army:

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